Pamunkey River and Tributaries Bacteria TMDL

Final Public Meeting
February 24 & 26, 2014

Why Are We Here?

To discuss bacteria TMDLs for the Pamunkey River and Tributaries watershed

A TMDL is the maximum amount of a pollutant a water body can receive and still meet water quality standards.

AKA "Pollution Diet"

Total Maximum Daily Load (TMDL) Equation

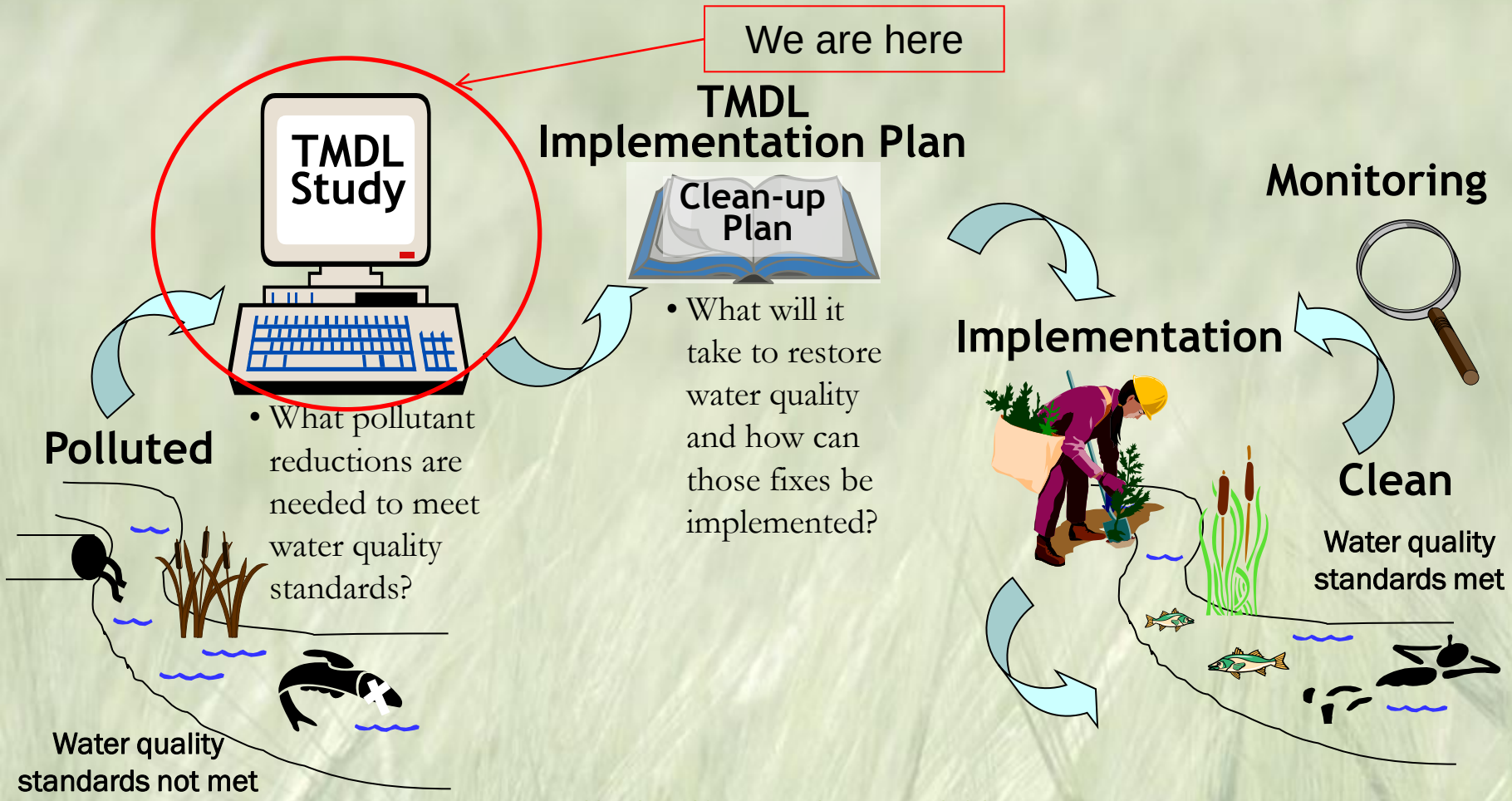
TMDL = Sum of WLA + Sum of LA + MOS

Where:

TMDL = Total Maximum Daily Load
WLA = Waste Load Allocation (point sources - permitted)
LA = Load Allocation (nonpoint sources)
MOS = Margin of Safety

A TMDL is the maximum amount of a pollutant a water body can receive and still meet water quality standards.

Overview of TMDL Process



Graphic adapted from Dr. Robert Brent, Virginia DEQ

Bacteria Impairment

- What are Fecal Bacteria?
  - Bacteria associated with feces from warm blooded animals (fecal coliform, *E. coli,* Enterococci)
- Why should we care?
  - Pathogens (including some strains of *E. coli)*
  - Parasites

Designated Uses

- Recreational
- Public Water Supply
- Wildlife
- Fish Consumption
- Shellfish
- Aquatic Life

The attainment of the recreational use is evaluated by testing for the presence of E. coli bacteria in freshwater systems and enterococci bacteria in transitional and salt waters.

Recreational Use Impairment:
Fecal Coliform, *E. coli* and Enterococci Bacteria

Escherichia coli:

- **Subset of fecal coliform bacteria**
- **Correlate better with swimming associated illness in freshwater**

Enterococci:

- **Subset of fecal streptococcus bacteria**
- **Indicator used for determining recreational risks in salt or transitional waters**

Indicator (CFU/100 ml)	Geometric Mean (4 or more samples in a Month)	Instantaneous Max (Single Sample)
E. Coli (Freshwater)	126	235
Enterococci (Transitional and Saltwater)	35	104

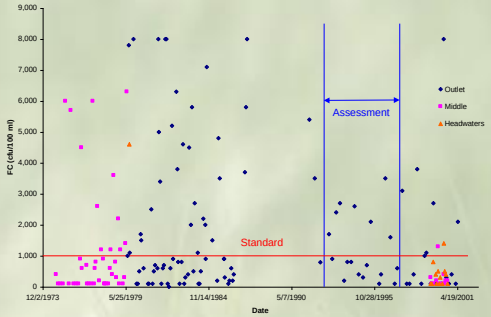
- ***Geometric Means calculated using data collected during any calendar month with a minimum of four weekly samples.***
- ***If insufficient data to calculate a monthly geometric mean, no more than 10% of the total samples in the assessment period should exceed the instantaneous standard.***

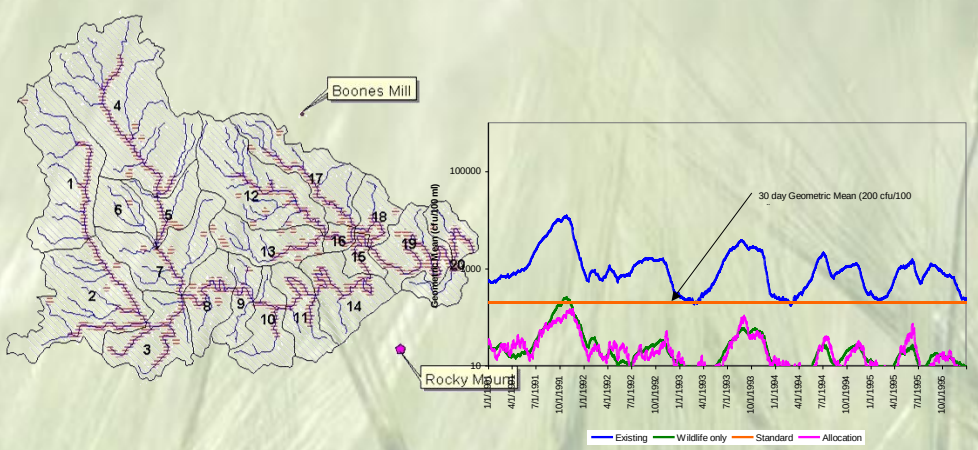
Study Approach

- Nested Watersheds
  - impairments are evaluated and grouped within watersheds with similar characteristics (slope, land use, hydrology, etc.)
- Identify and quantify sources of bacteria
- Incorporate watershed characteristics and estimated bacteria source loads to establish the baseline for current bacteria load
- Determine reductions needed for standards to be met (difference between current load conditions and standards)

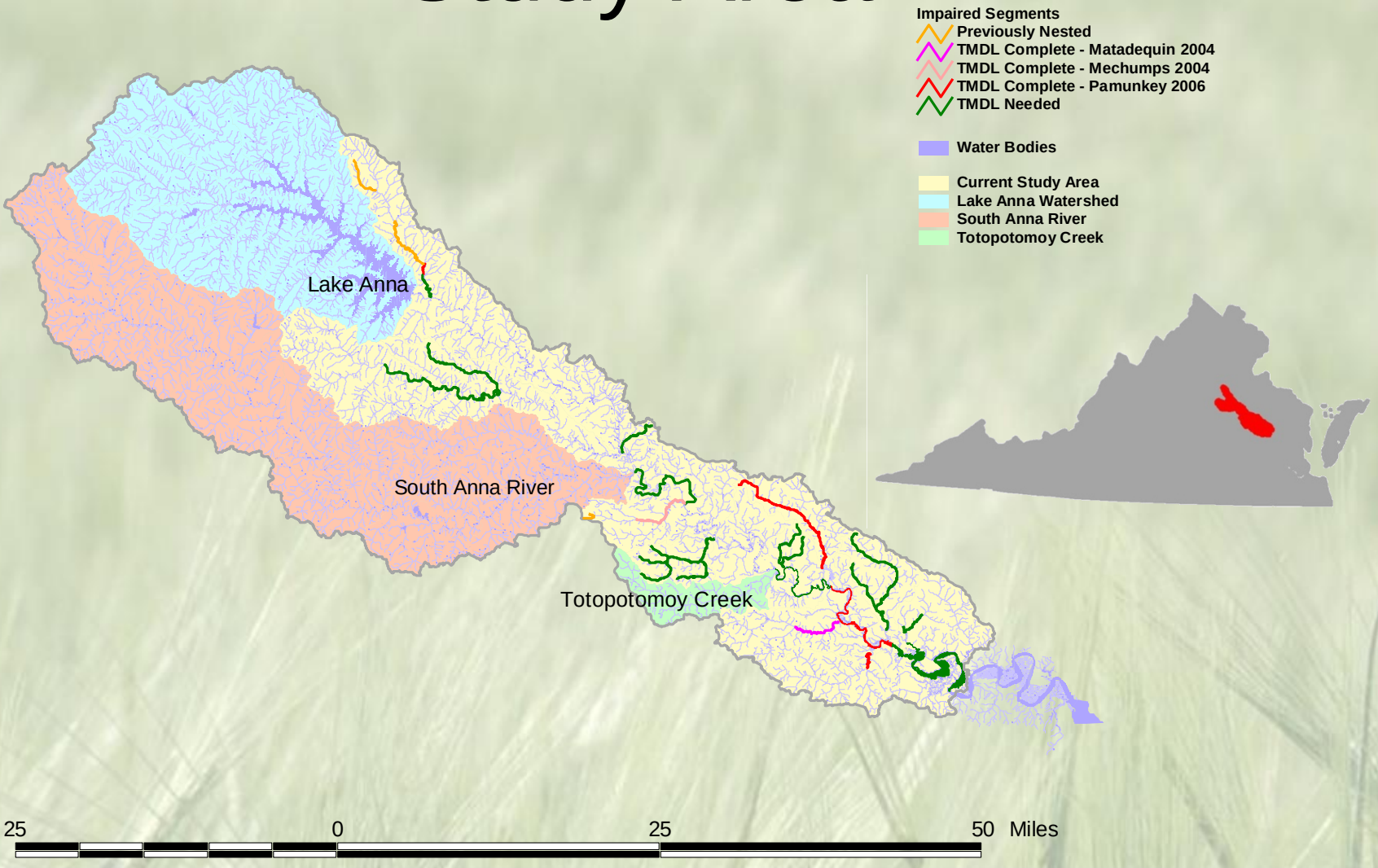
Major Components of the TMDL

- Source Assessment
- Modeling
  - Hydrology
  - Water Quality
  - Load Allocation
- Public Participation

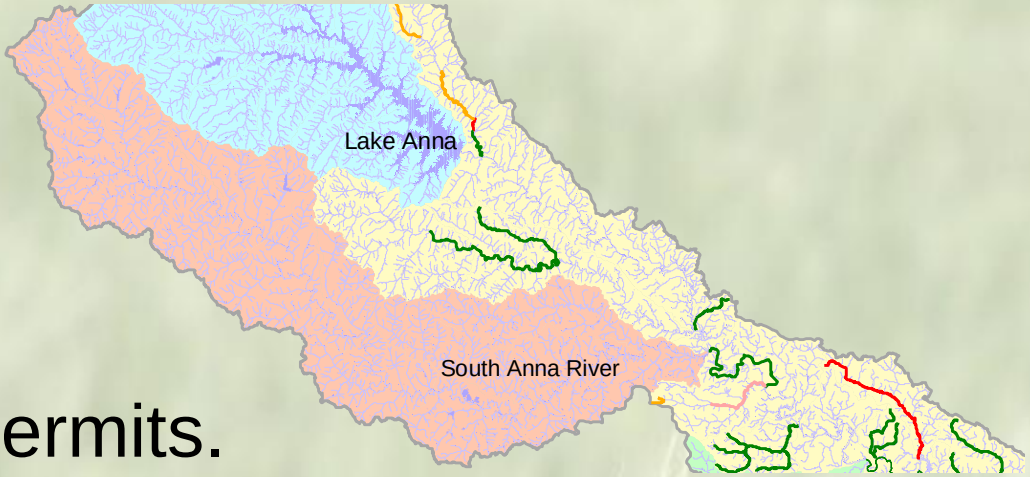




Study Area


Impaired Segments
Previously Nested
TMDL Complete - Matadequin 2004
TMDL Complete - Mechumps 2004
TMDL Complete - Pamunkey 2006
TMDL Needed
Water Bodies
Current Study Area
Lake Anna Watershed
South Anna River
Totopotomoy Creek
Lake Anna
South Anna River
Totopotomoy Creek
25 0 25 50 Miles

South Anna River TMDL Modification



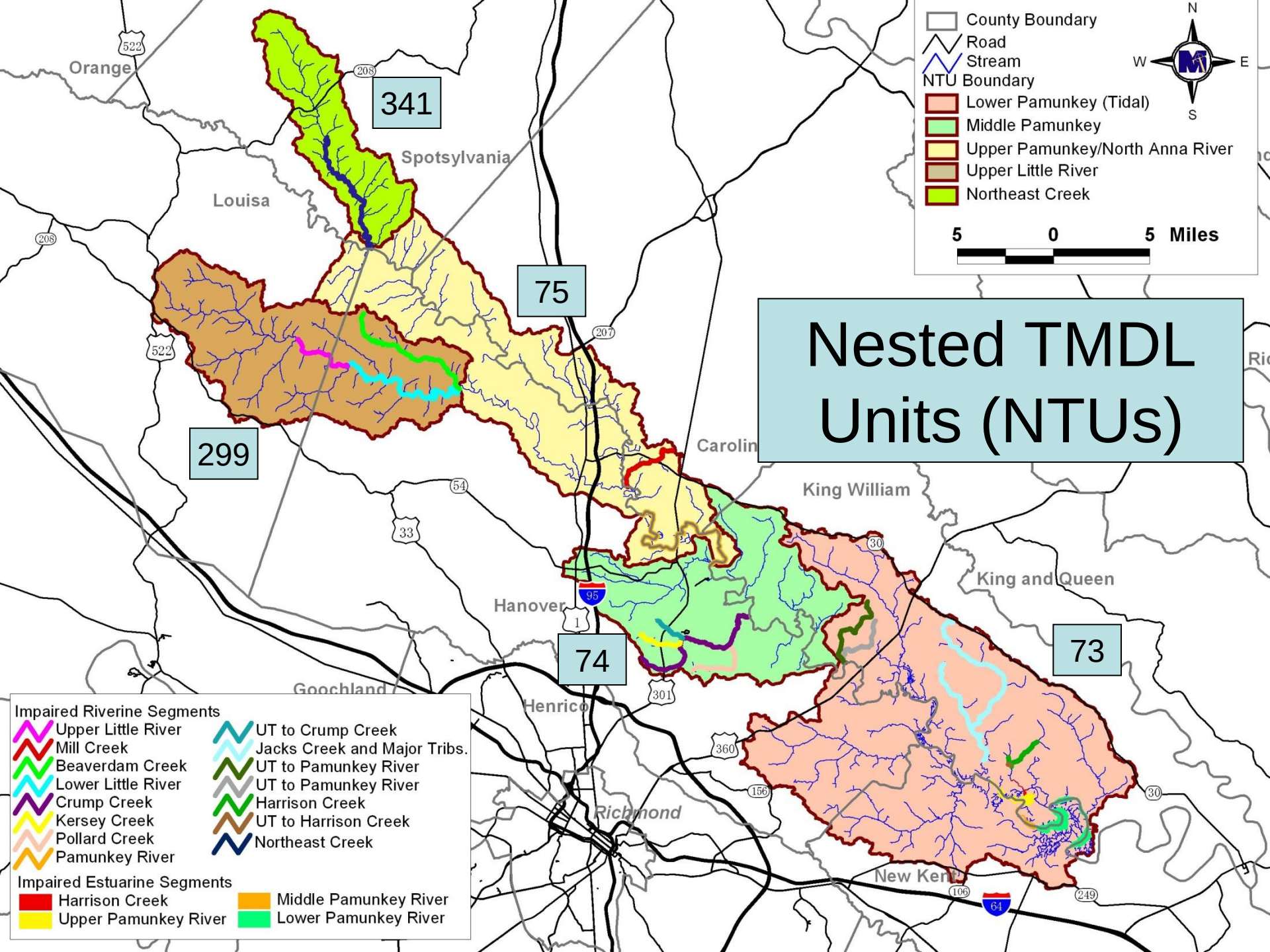
- Updated permits.
- Accounted for future growth in the TMDL tables.
- Adjusted future growth in Taylors Creek to allow for a small number of single-family home discharges.
- Maintained load reductions from original TMDL.

South Anna River TMDL Modification

(Bacteria Colonies per Year)

Impairment	WLA	LA	MOS	TMDL
South Anna River (VAN-F01R-01)	**4.92E+12**	**8.98E+11**		**5.82E+12**
Permits	1.64E+12			
Future Load	3.28E+12			
South Anna River (VAN-F02R-01)	**7.50E+12**	**1.38E+13**		**2.13E+13**
Permits	1.5E+12			
Future Load	6.00E+12			
South Anna River (VAN-F04R-01)	**7.74E+12**	**4.42E+13**		**5.19E+13**
Permits	1.55E+12			
Future Load	6.19E+12			
South Anna River (VAN-F04R-02)	**6.02E+12**	**4.49E+13**		**5.09E+13**
Permits	3.48E+12			
Future Load	2.54E+12			
Taylors Creek (VAN-F03R-01)	**3.66E+10**	**6.47E+11**		**6.83E+11**
Permits	1.74E+09			
Future Load	3.48E+10			

Implicit


Nested TMDL Units (NTUs)
341
75
299
74
73
County Boundary
Road
Stream
NTU Boundary
Lower Pamunkey (Tidal)
Middle Pamunkey
Upper Pamunkey/North Anna River
Upper Little River
Northeast Creek
5 0 5 Miles
N
W
E
S
Impaired Riverine Segments
Upper Little River
Mill Creek
Beaverdam Creek
Lower Little River
Crump Creek
Kersey Creek
Pollard Creek
Pamunkey River
UT to Crump Creek
Jacks Creek and Major Tribs.
UT to Pamunkey River
UT to Pamunkey River
Harrison Creek
UT to Harrison Creek
Northeast Creek
Impaired Estuarine Segments
Harrison Creek
Upper Pamunkey River
Middle Pamunkey River
Lower Pamunkey River
Orange
Louisa
Spotsylvania
Hanover
Goochland
Henrico
Richmond
King William
King and Queen
New Kent

E.coli Impairments

Stream Name Impairment ID	Imp. Type	Initial Listing Year	2012 River Miles (Sq Miles)	2012 Listing Violation	Impairment Location Description
Beaverdam Creek VAP-F11R_BDC01A12	E. coli	2012	8.47	44%	From the headwaters to its confluence with the Little River.
Crump Creek VAP-F12R_CRU01A02	E. coli	2008	10.08	15% 25% 17%	From its headwaters to its mouth.
Crump Creek X-Trib. VAP-F12R_XJC01A12	E. coli	2012	1.79	42%	From the headwaters to its confluence with Crump Creek.
Harrison Creek VAP-F14R_HSN01A00	E. coli	2008	2.80	37% 38% 17%	Upstream of a pond at Elsing Green downstream to the nearest tributary.
Harrison Creek VAP-F14E_HSN01A12	E. coli	2012	(0.05)	33%	Tidal portion of Harrison Creek at its mouth.
Harrison Creek X-Trib. VAP-F14R_XJD01A12	E. coli	2012	0.16	50%	From its headwaters to its confluence with Harrison Creek.

E.coli Impairments

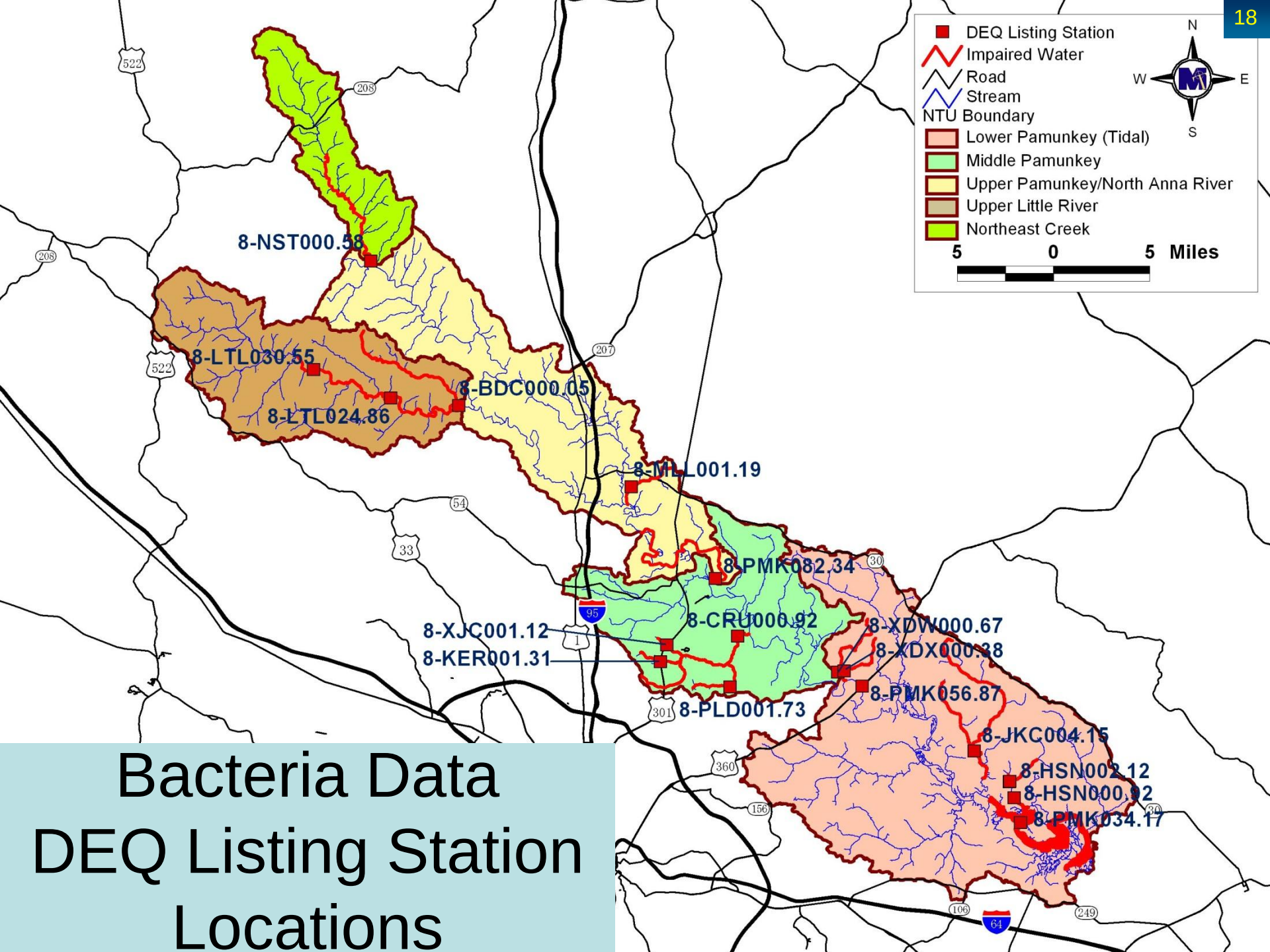
Stream Name Impairment ID	Imp. Type	Initial Listing Year	2012 River Miles	2012 Listing Violation	Impairment Location Description
Jacks Creek & Tribs. VAP-F13R_JCK01A98	E. coli	2008	21.05	18%	From its headwaters downstream to its confluence with the Pamunkey River.
Kersey Creek VAP-F12R_KER01A12	E. coli	2012	2.76	25%	From its headwaters downstream to its confluence with Crump Creek.
Little River VAN-F10R_LTL01A02	E. coli	2006	4.01	23%	From its confluence with Hawkins Creek downstream to its confluence with Locust Creek.
Little River VAP-F11R_LTL01B08	E. coli	2008	10.77	25%	From its confluence with Locust Creek downstream to its confluence with Beaverdam Creek.
Mill Creek VAP-F09R_MLL01A12	E. coli	2012	4.39	54%	From its headwaters downstream to its confluence with the North Anna River.
Northeast Creek VAN-F09R_NST01A08	E. Coli	2008	2.74	25%	beginning at the confluence with an unnamed tributary to Northeast Creek and continuing downstream until the confluence with the North Anna River

E.coli Impairments

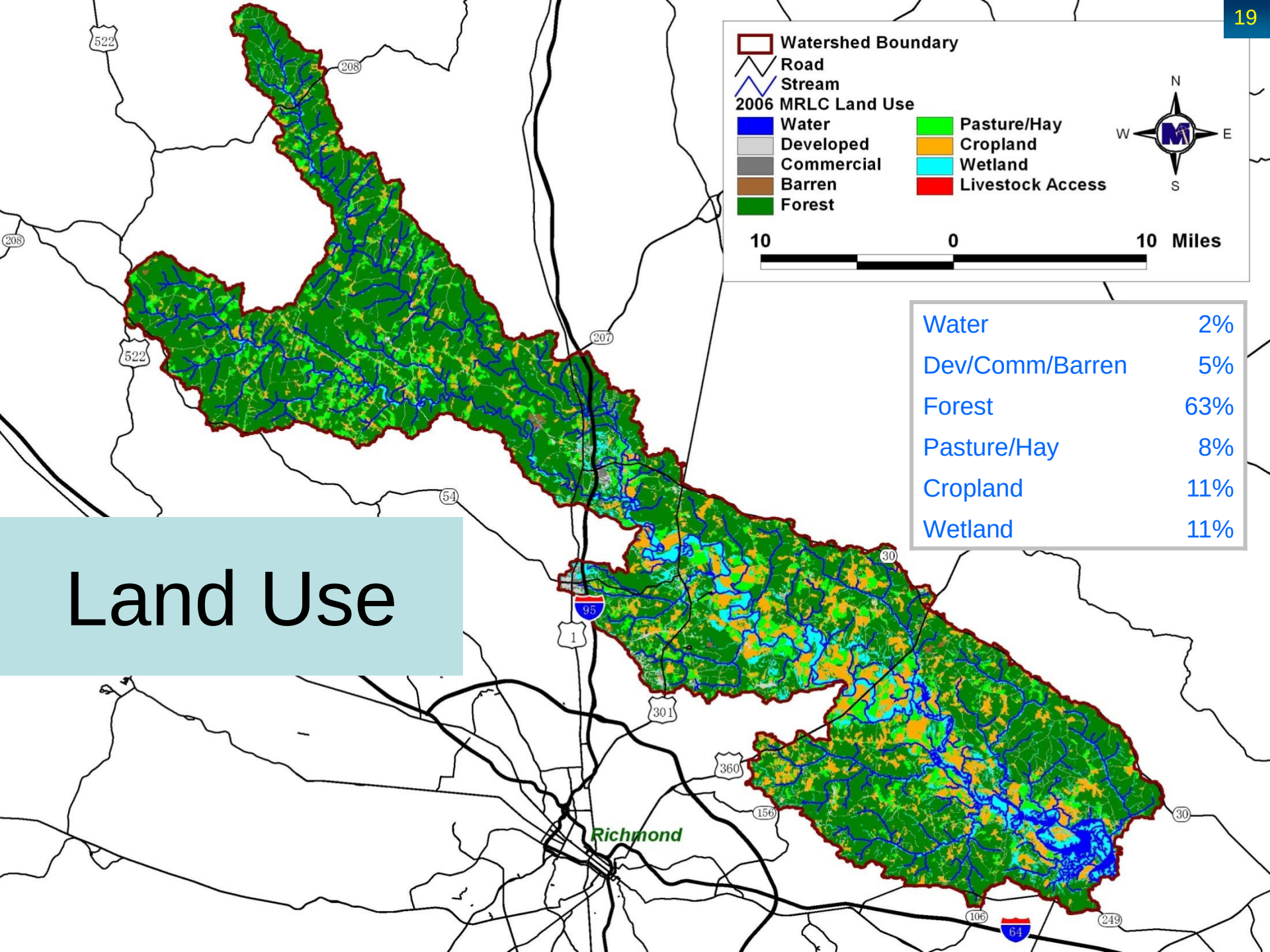
Stream Name Impairment ID	Imp. Type	Initial Listing Year	2012 River Miles	2012 Listing Violation	Impairment Location Description
Pamunkey River X-Trib. VAP-F13R_XDW01A08	E. coli	2012	5.51	25%	From its headwaters downstream to its confluence with the Pamunkey River.
X-Trib Pamunkey River X-Trib VAP-F13R_XDX01A04	E. coli	2012	3.85	25%	From its headwaters downstream to its confluence with Pamunkey Tributary (XDW).
Pollard Creek VAP-F12R_PLD01A12	E. coli	2012	4.06	17%	From its headwaters downstream to its confluence with Crump Creek.
Pamunkey River VAP-F12R_PMK01B08	E. coli	2008	12.26	16%	From its headwaters downstream to its confluence with Mechumps Creek.

E.coli Impairments

Stream Name Impairment ID	Imp. Type	Initial Listing Year	2012 Sq Miles	2012 Listing Violation	Impairment Location Description
Pamunkey River VAP-F14E_PMK02A00	E. coli	2010	0.81	13%	From Macon Creek downstream to river mile 34.25.
Pamunkey River VAP-F14E_PMK03A00	E. coli	2010	0.38	13%	A one mile radius around VADEQ monitoring station 8-PMK032.00.
Pamunkey River VAP-F14E_PMK04A00	E. coli	2010	2.44	13%	One mile downstream of 8-PMK032.00 and extends to the downstream extent of tidal freshwater segment at approximately river mile 23.6.



Bacteria Data DEQ Listing Station Locations

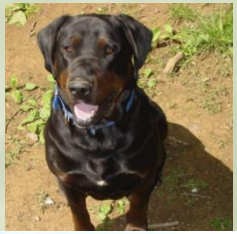


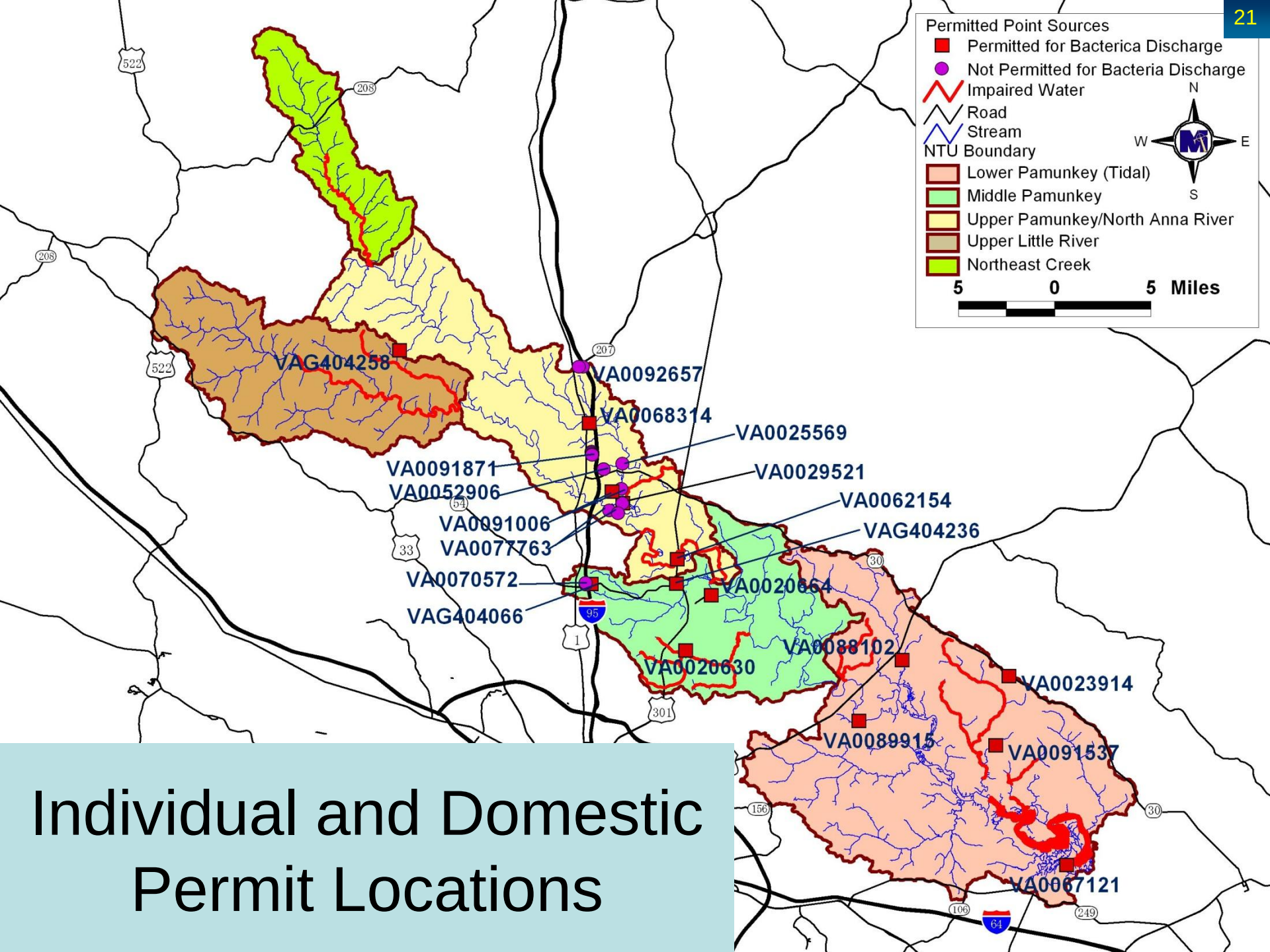
Land Use

Water	2%
Dev/Comm/Barren	5%
Forest	63%
Pasture/Hay	8%
Cropland	11%
Wetland	11%

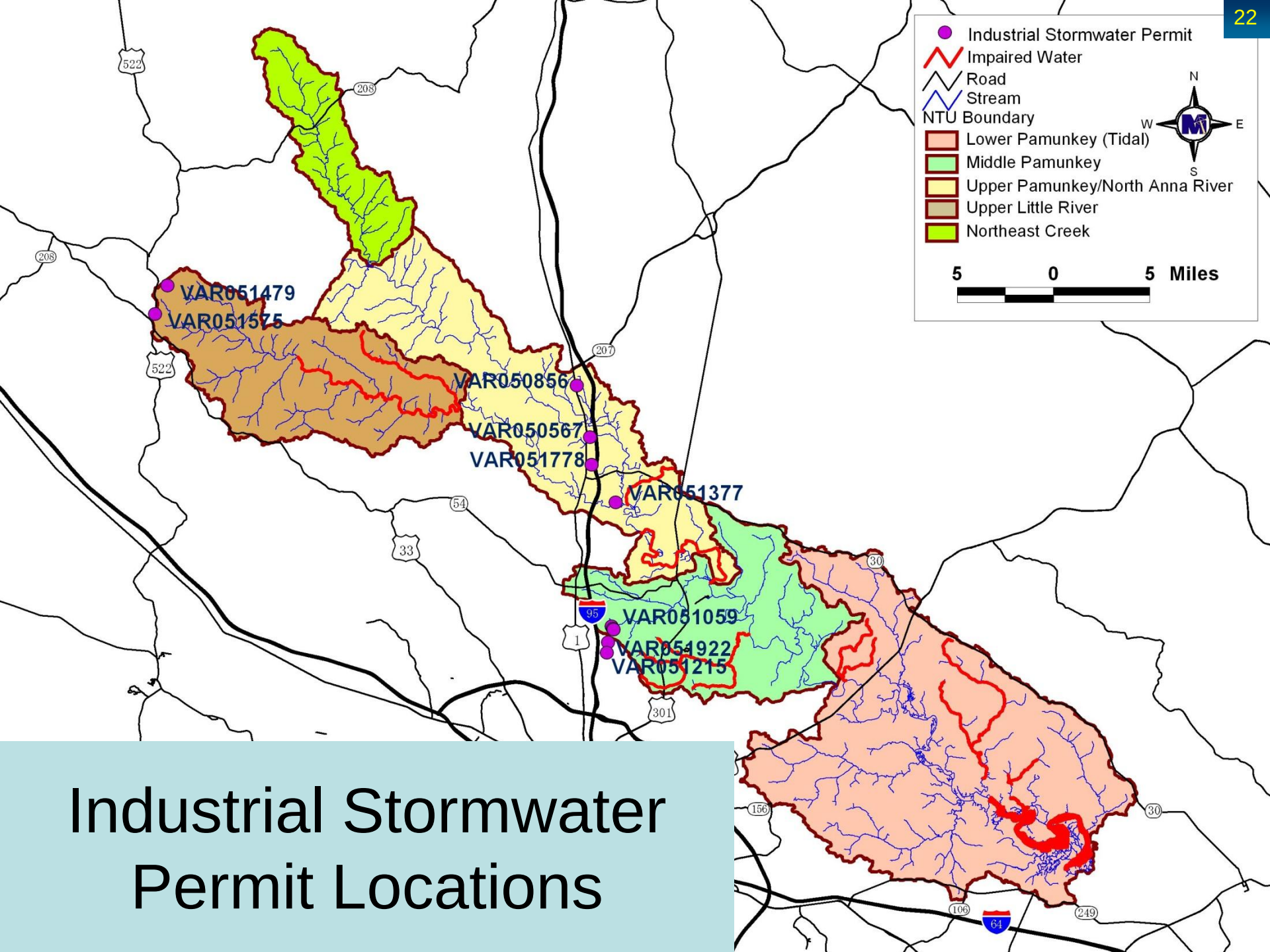
Source Assessment

- Permitted discharges
  - Wastewater treatment facilities
  - Other Permitted Discharges
- Human
  - Failed Septic Systems
  - Straight Pipes
  - Overflows
- Pets
- Livestock
- Wildlife





Individual and Domestic Permit Locations



Industrial Stormwater Permit Locations

Permitted Discharges – MS4

Permit No	Permittee	Type	WLA for Bacteria?
VAR040012	Hanover County	II	Yes
VAR040011	Town of Ashland	II	Yes
VAR040115	VDOT	II	Yes

How do we determine a TMDL?

+ Watershed data

TMDL

Bacteria Reduction Goals

% Reduction in Fecal Bacteria Loading from Existing Conditions					
Impaired Segment Grouping	**Wildlife**	**Livestock Direct**	**Cropland/ Pasture**	**Straight Pipes**	**Residential/ Commercial**
Upper Little River	25	100	70	100	70
Northeast Creek	0	100	80	100	80
Upper Pamunkey / North Anna River	25	100	99	100	99
Middle Pamunkey	20	100	99	100	99
Lower Pamunkey	30	100	99	100	99

TMDL Table

- Bacteria Colonies per Year

Impairment	WLA	LA	MOS	TMDL
Upper Little River	**5.74E+12**	**2.75E+14**		**2.80E+14**
Permits	1.33E+11			
Future Load	5.61E+12			
Northeast Creek	**2.34E+12**	**1.15E+14**		**1.17E+14**
Permits	0.00E+00			
Future Load	2.34E+12			
Upper Pamunkey / North Anna River	**2.32E+13**	**8.80E+14**		**9.03E+14**
Permits	5.14E+12			
Future Load	1.81E+13			
Middle Pamunkey	**2.36E+13**	**1.06E+15**		**1.08E+15**
Permits	1.92E+12			
Future Load	2.17E+13			
Lower Pamunkey	**4.17E+13**	**1.76E+15**		**1.80E+15**
Permits	5.69E+12			
Future Load	3.60E+13			

Implicit

And then:

- Public Review (30 days)
- Submit to EPA
- State Approval
- Implementation Plan Development
- Implementation

Contact Information

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Glen Allen, VA 23060

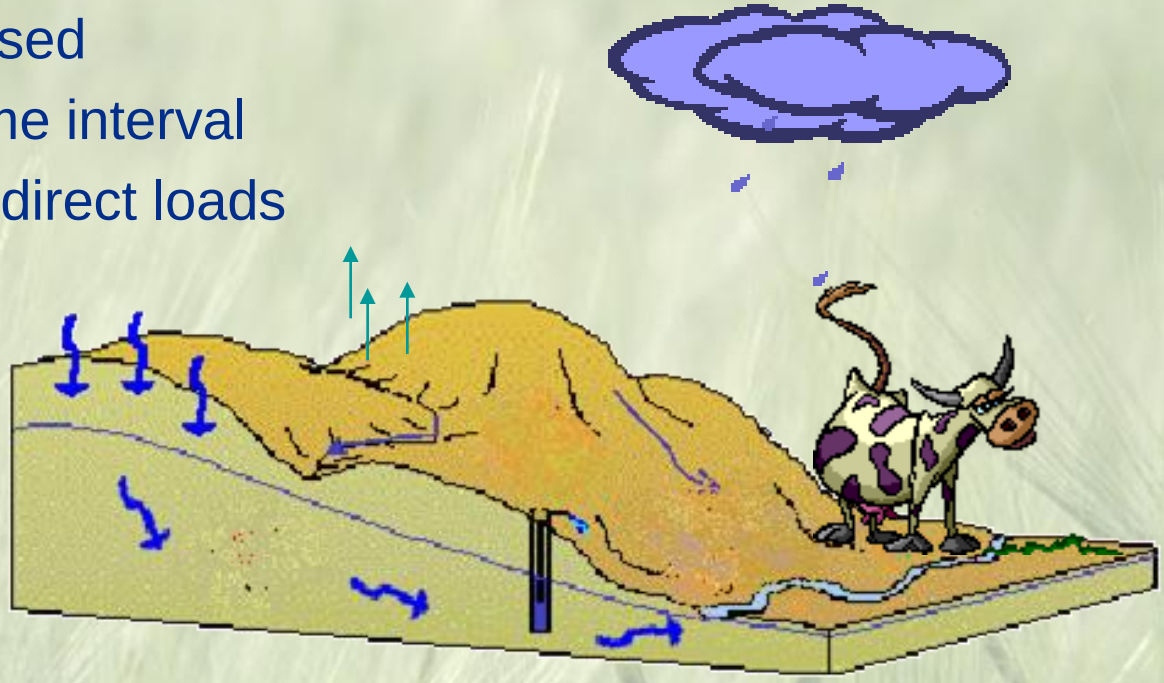
Send Written Comments to Mark by:
Monday March 28, 2014

Appendix A

Modeling

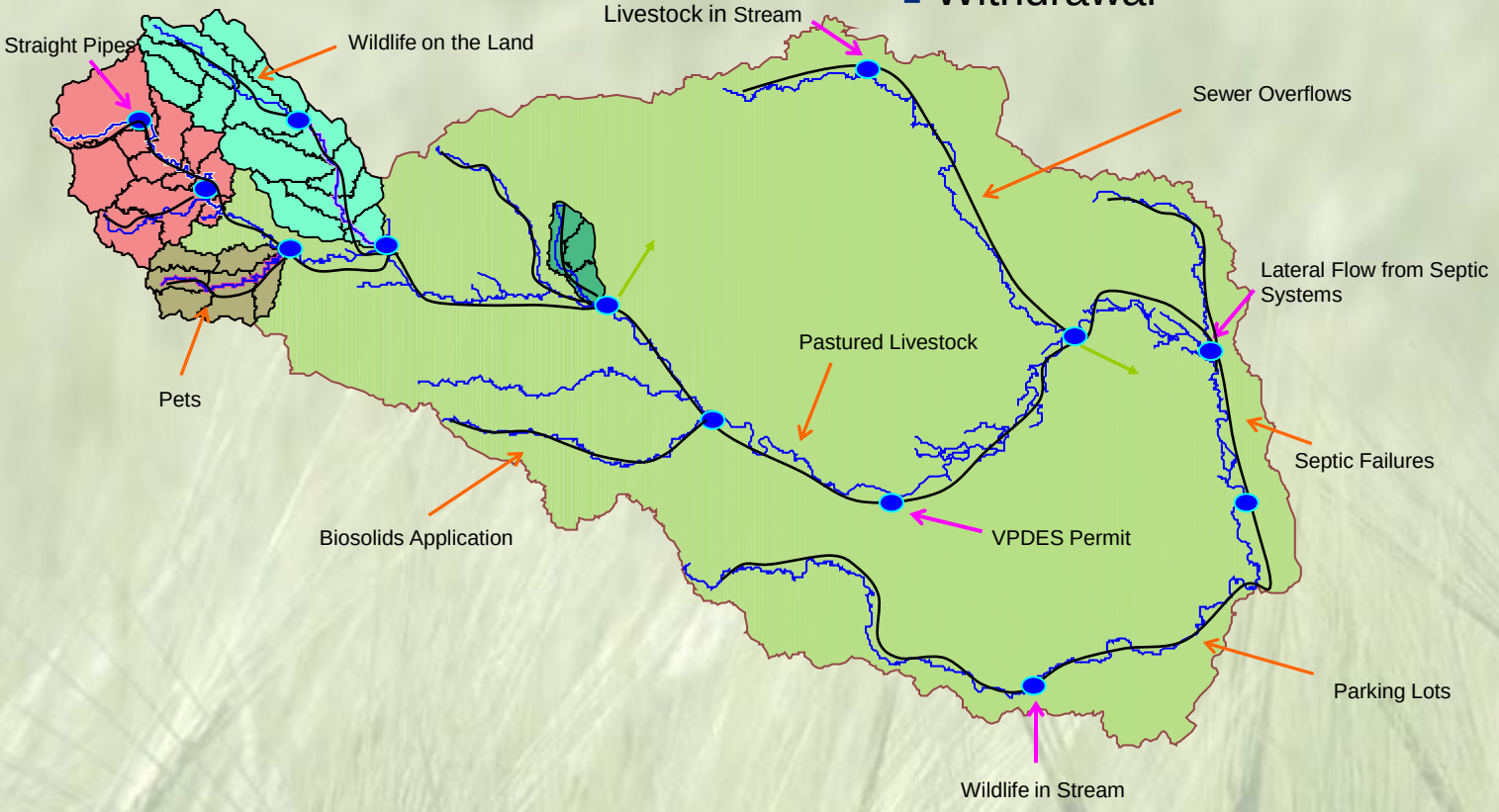
Modeling - Bacteria

- Rainfall-Runoff-Water Quality
  - Hydrologic Simulation Program – Fortran (HSPF)
    - Watershed-based
    - Continuous time interval
    - Land-applied, direct loads



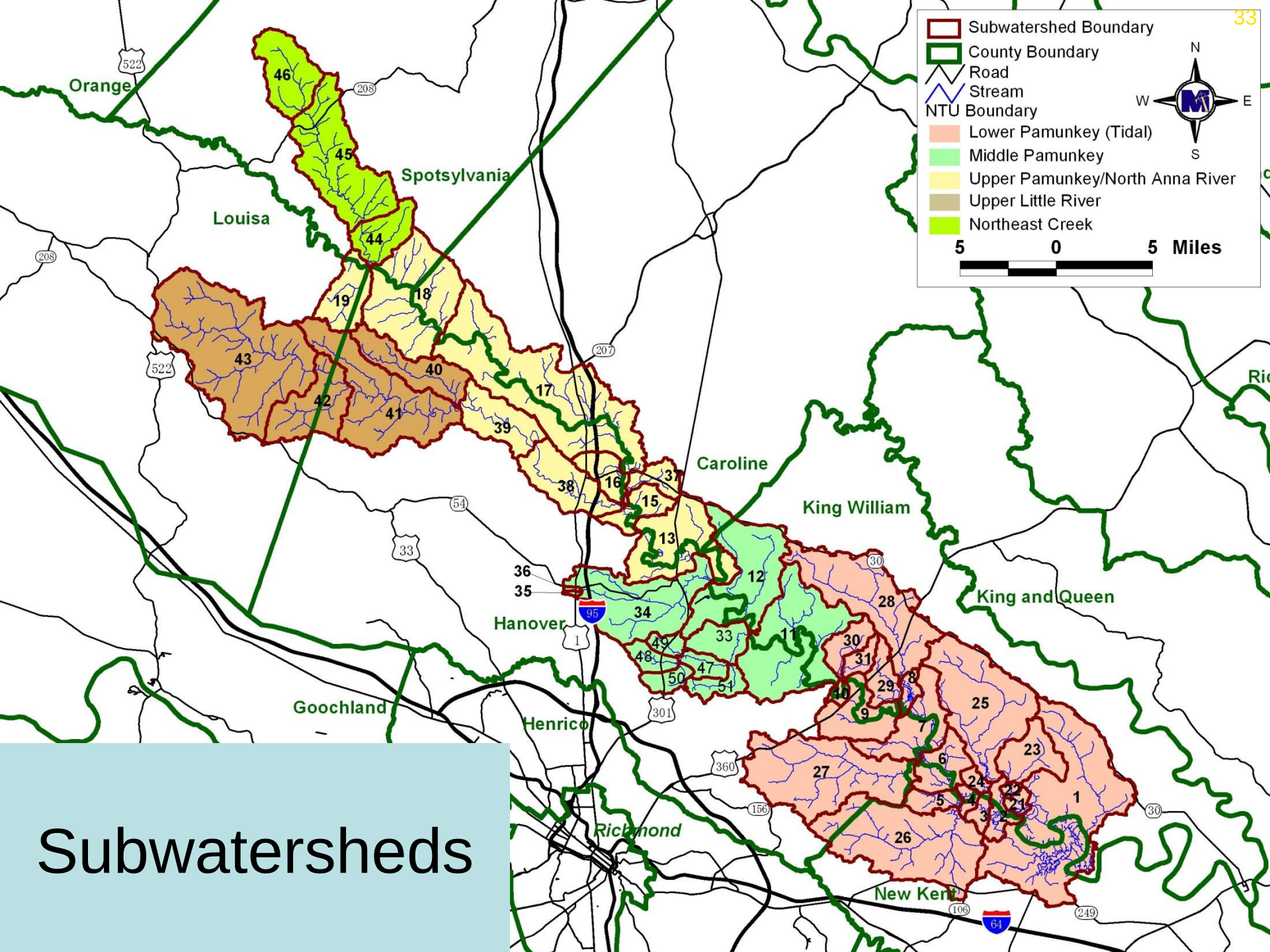
Conceptual Model

- Mathematical Representation
- Overland
- Direct discharges
- Withdrawal



Appendix B

Source Assessment by Subwatershed



Subwatersheds

Human Source

- Population, housing units, and onsite treatment system based on U.S. Census resulting in:
  - HU on sewer, septic, and “other”
- Initial estimates revised based on counties and VDH responses.
- “Other” category is broken down into Privies/Outhouses (90%) and straight pipes (10%)

Human

Sub. ID	Population	HU on Sewer	HU on Septic	HU on Privies / Outhouses	Straight Pipes	Failing Septics	Sub. ID	Population	HU on Sewer	HU on Septic	HU on Privies / Outhouses	Straight Pipes	Failing Septics
1	1,129	3	434	13	1	9	27	4,345	36	1,685	14	2	2
2	34	0	18	1	0	0	28	2,588	15	975	33	4	4
3	9	0	4	0	0	0	30	202	1	76	1	0	0
4	6	0	3	0	0	0	31	121	0	43	1	0	0
5	113	0	59	1	0	2	33	255	0	96	2	0	0
6	100	0	47	2	0	1	34	6,502	1,262	903	69	8	30
7	394	3	158	3	0	4	35	966	438	1	0	0	0
8	24	0	8	0	0	0	36	631	369	1	1	0	0
9	625	7	250	5	1	8	37	320	7	105	16	2	4
10	4	0	3	0	0	0	38	749	2	295	13	1	10
11	1,615	7	611	9	1	14	39	473	1	177	3	0	6
12	871	1	200	7	1	4	40	545	12	192	13	1	6
13	525	8	70	18	2	3	41	1,501	5	576	29	3	18
15	129	18	28	6	1	1	42	816	2	322	19	2	8
16	308	4	125	10	1	4	43	2,639	0	1,036	70	8	21
17	2,643	50	973	58	6	32	44	531	1	180	7	1	6
18	1,446	46	483	21	2	16	45	1,688	5	602	18	2	20
19	396	0	165	7	1	3	46	595	0	222	8	1	7
21	2	0	2	0	0	0	47	667	0	267	4	0	9
22	0	0	0	0	0	0	48	1,415	110	417	40	4	14
23	153	0	57	4	0	2	49	330	2	128	2	0	4
24	8	0	3	0	0	0	50	1,093	50	389	2	0	13
25	848	2	346	12	1	1	51	699	5	273	3	0	9
26	3,695	291	1,120	9	1	1	***Total***	***44,748***	***2,763***	***14,128***	***554***	***58***	***296***

Pet Sources

- Population/household based on literature values, veterinarians, and animal control
- Based on finalized number of housing units by sub-watershed.
- Densities used were:
  - 0.53 dog per housing unit
  - 0.6 cat per housing unit

Pets

Subshed ID	Dogs	Cats	Subshed ID	Dogs	Cats
1	241	270	27	1,020	1,475
2	10	11	28	547	613
3	2	2	30	42	47
4	2	2	31	24	26
5	32	36	33	58	65
6	26	30	34	1,317	1,475
7	93	105	35	258	289
8	4	5	36	218	244
9	150	168	37	69	78
10	2	2	38	183	205
11	355	398	39	107	120
12	116	130	40	128	143
13	145	163	41	357	399
15	28	32	42	189	212
16	82	92	43	595	666
17	594	665	44	101	113
18	306	343	45	335	375
19	95	106	46	123	138
21	1	2	47	159	178
22	0	0	48	335	376
23	33	37	49	78	87
24	2	2	50	259	290
25	193	216	51	166	185
26	771	864	***Total***	***17,799***	***11,148***

Livestock Sources

- Initial estimates of populations are obtained from Virginia Agricultural Statistics and DCR's confined animal operations data.
- The county-wide statistics are broken down into sub-watershed level using the portion of pasture within a subwatershed as compared to the county-wide pasture acreage.
- Estimates were revised (except for horses) based on consultation with SWCD, NRCS, VADCR, and VCE

Livestock (1 of 2)

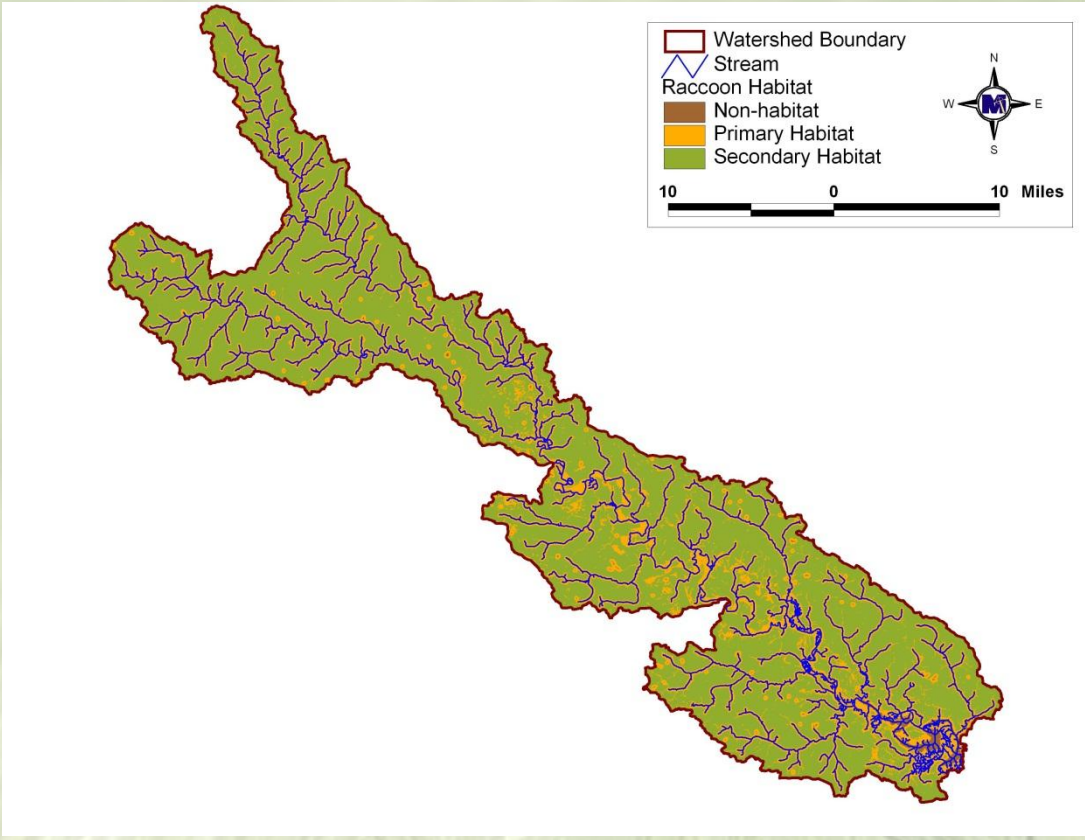
Subshed ID	Beef Cattle	Beef Calves	Dairy Milkers	Dairy Heifers	Dairy Calves	Sheep	Horses	Chickens	Goats
1	47	54	7	3	3	0	34		67
2	6	7	1	0	0	0	5		8
3	3	3	0	0	0	0	4		3
4	3	3	0	0	0	0	4		3
5	11	11	0	0	0	0	15		12
6	39	39	1	0	0	0	49		43
7	97	0	103	52	52	7	43		38
8	10	10	1	1	1	0	5		9
9	165	127	156	78	78	12	74		72
10	18	15	0	0	0	2	8		3
11	194	31	162	81	81	12	88		119
12	80	87	9	5	5	4	40		82
13	69	62	1	1	1	8	30		32
15	30	24	0	0	0	4	13		8
16	47	38	0	0	0	5	20		10
17	173	140	0	0	0	21	74		46
18	223	203	4	2	2	16	63		34
19	61	49	0	0	0	4	15		10
21	10	13	2	1	1	0	5		16
22	4	5	1	0	0	0	2		7
23	5	6	1	0	0	0	2		8
24	0	0	0	0	0	0	0		0
25	38	46	8	4	4	0	20		60
26	42	41	0	0	0	1	50		39

Livestock (2 of 2)

Subshed ID	Beef Cattle	Beef Calves	Dairy Milkers	Dairy Heifers	Dairy Calves	Sheep	Horses	Chickens	Goats
27	164	134	0	0	0	14	75		33
28	43	52	9	4	4	0	22		68
30	12	14	2	1	1	0	6		18
31	3	4	1	0	0	0	2		5
33	25	20	0	0	0	2	11		4
34	154	125	0	0	0	14	67		27
35	0	0	0	0	0	0	0		0
36	0	0	0	0	0	0	0		0
37	23	19	0	0	0	5	9		11
38	42	34	0	0	0	4	18		7
39	71	58	0	0	0	6	31		13
40	175	142	0	0	0	16	75		31
41	304	170	132	66	66	28	135		56
42	120	97	0	0	0	10	44		23
43	293	196	0	0	0	20	64	60,800	58
44	111	119	0	0	0	2	23		5
45	190	170	0	0	0	5	52		11
46	54	58	0	0	0	1	11		2
47	14	11	0	0	0	1	6		2
48	24	20	0	0	0	2	11		4
49	19	16	0	0	0	2	8		3
50	25	20	0	0	0	2	11		4
51	24	20	0	0	0	2	10		4
Total	3,265	2,513	601	299	299	232	1,354	60,800	1,118

Wildlife Source

- Population
  - – Animal densities from VDGIF biologists
  - – Habitat from literature values and GIS
- Distribution of waste based on habitat
  - – Land-applied
  - – Direct deposition to the stream
- Seasonal variations based on migration patterns and food sources
- Example: If raccoon density were 0.0343 animal per acre of habitat, and there were 188,777 acres of raccoon habitat, then raccoon population would be 0.0343 * 188,777 = 6,475 raccoon.



Wildlife

Sub ID	Raccoon	Muskrat	Duck	Goose	Deer	Turkey	Beaver	Sub ID	Raccoon	Muskrat	Duck	Goose	Deer	Turkey	Beaver
1	1,839	1,715	183	104	898	227	462	27	1,312	697	74	42	640	161	135
2	130	175	19	11	63	16	50	28	1,099	608	65	37	531	132	114
3	74	82	9	5	36	9	19	30	201	96	10	6	98	25	21
4	56	107	11	6	27	7	27	31	110	50	5	3	54	14	10
5	139	138	15	8	68	17	31	33	249	132	14	8	121	28	26
6	291	279	30	17	142	37	70	34	954	518	55	31	454	106	107
7	499	407	43	25	244	63	105	35	10	1	0	0	4	0	25
8	82	135	14	8	40	10	44	36	10	0	0	0	3	0	57
9	655	395	42	24	320	81	82	37	176	125	13	8	86	20	54
10	49	49	5	3	24	6	10	38	515	275	29	17	250	61	58
11	1,205	702	75	42	589	149	142	39	456	291	31	18	218	57	151
12	971	516	55	31	474	122	105	40	480	285	30	17	233	60	70
13	805	554	59	33	392	99	113	41	1,189	742	79	45	581	148	248
15	235	182	19	11	115	29	42	42	581	336	36	20	283	72	50
16	221	109	12	7	97	20	23	43	2,072	1,191	127	72	1,010	258	158
17	1,973	1,236	132	75	956	239	248	44	332	232	25	14	162	42	44
18	1,127	751	80	45	550	140	155	45	1,053	718	77	43	513	130	0
19	379	239	25	14	185	48	49	46	508	206	22	12	248	62	0
21	62	78	8	5	30	8	19	47	131	69	7	4	63	15	14
22	29	25	3	2	14	4	5	48	140	74	8	4	68	16	15
23	354	179	19	11	173	44	31	49	92	49	5	3	45	10	10
24	64	57	6	3	31	8	12	50	129	68	7	4	63	15	13
25	1,176	615	65	37	574	146	132	51	162	85	9	5	78	18	17
26	1,424	811	86	49	695	177	166	**Total**	**25,800**	**16,384**	**1,743**	**989**	**12,543**	**3,156**	**3,539**

Appendix C

Complete TMDL Tables

Northeast Creek

Impairment NTU 341	WLA[1] (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
Northeast Creek	2.34E+12	1.15E+14	*Implicit*	1.17E+14
Future Load	*2.34E+12*			

Upper Little River

Impairment NTU 299	WLA[1] (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
Upper Little River	5.74E+12	2.75E+14	*Implicit*	2.80E+14
VAG404258	*1.74E+09*			
MS4 Hanover County (VAR040012) *MS4 VDOT in Hanover County* } [2]	*1.31E+11*			
Future Load	*5.61E+12*			

Upper Pamunkey / North Anna

Impairment NTU 75	WLA[1] (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
Upper Pamunkey/North Anna River	2.32E+13	8.80E+14	*Implicit*	9.03E+14
VA0062154	*1.39E+11*			
VA0029521	*1.74E+12*			
VA0068314	*8.71E+09*			
MS4 Hanover County (VAR040012) *MS4 VDOT in Hanover County* } [2]	*3.26E+12*			
Future Load	*1.81E+13*			

Middle Pamunkey River

Impairment NTU 74	WLA[1] (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
Middle Pamunkey River	2.36E+13	1.06E+15	*Implicit*	1.08E+15
VA0020664	*6.05E+10*			
VA0020630	*3.31E+10*			
VAG404066	*1.74E+09*			
VAG404236	*1.74E+09*			
MS4 Hanover County (VAR040012) *MS4 Town of Ashland (VAR040011)* *MS4 VDOT in Hanover County*	} [2] *1.83E+12*			
Future Load	*2.17E+13*			

Lower Pamunkey River

Impairment NTU 73	WLA[1] (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
Lower Pamunkey River	5.38E+13	1.75E+15	*Implicit*	1.80E+15
VA0067121	*5.23E+10*			
VA0089915	*1.74E+13*			
VA0023914	*3.48E+10*			
VA0091537	*1.39E+10*			
VA0088102	*1.74E+11*			
MS4 Hanover County (VAR040012) *MS4 VDOT in Hanover County* } [2]	*1.10E+11*			
Future Load	*3.60E+13*			

TMDL Table Footnotes

1. The WLA reflects an allocation for potential future permits issued for bacteria control. Any issued permit will include bacteria effluent limits in accordance with applicable permit guidance and will ensure that the discharge meets the applicable numeric water quality criteria for bacteria at the end-of-pipe.

2. Each of the municipality MS4 loads has been aggregated with a portion of the adjacent VDOT MS4 load, due to the continuity of the system. For MS4/VSMP permits, the permittee may address the TMDL WLAs for stormwater through the iterative implementation of programmatic BMPs.

Appendix D

Background

Watershed Size

Watershed	Acreage
Lower Pamunkey River	141,743
Middle Pamunkey River	58,016
Upper Pamunkey River / North Anna River	84,469
Upper Little River	61,883
Northeast Creek	27,017

Land Use / Land Cover

Watershed	Forest	Cropland	Pasture	Wetland	Developed	Water	Barren	Commercial	LAX	Acreage
Lower Pamunkey River	57%	15%	6%	14%	4%	3%	< 1%	< 1%	< 1%	141,743
Middle Pamunkey River	52%	16%	10%	14%	7%	< 1%	< 1%	< 1%	< 1%	58,016
Upper Pamunkey / North Anna River	71%	7%	7%	8%	5%	1%	< 1%	< 1%	< 1%	84,469
Upper Little River	73%	6%	12%	5%	3%	< 1%	< 1%	< 1%	< 1%	61,883
Northeast Creek	76%	6%	7%	6%	4%	< 1%	< 1%	< 1%	< 1%	27,017

Values in table are in percent
Source of data is the 2006 Multi-Resolution Land Cover (MRLC) Data
LAX is livestock access which represents areas of pasture adjacent to water bodies

Water Quality Data Analysis -*E.coli*

Creek	Listing Station	Date	Count	Min.	Max.	Mean	Median	St. Dev.	Violation[1] %
Beaverdam Creek	8-BDC000.05	02/09 – 11/10	9	50	2,000	472	200	641.34	44.4
Crump Creek	8-CRU000.92	06/05 – 12/10	33	13	8,000	369	100	1,379.28	15.2
Harrison Creek	8-HSN000.92	04/10 – 03/11	12	100	800	225	100	226.13	25.0
Harrison Creek	8-HSN002.12	05/05 – 03/11	22	25	1,400	306	100	414.36	31.8
Jacks Creek and Tributaries	8-JKC004.15	07/03 – 10/11	32	20	1,200	165	100	233.43	21.9
Kersey Creek	8-KER001.31	01/10 – 12/10	12	25	550	177	110	191.68	25.0
Little River	8-LTL024.86	06/05 – 10/11	24	25	650	141	50	188.04	20.8
Little River	8-LTL030.55	03/03 – 7/12	46	25	2000	229	75	466.72	23.9
Mill Creek	8-MLL001.19	02/09 – 11/10	13	25	3,400	915	500	1,016.50	53.8
Northeast Creek	3-NST000.58	08/04 – 07/05	12	10	510	139	40	182.7297	25.0
Pollard Creek	8-PLD001.73	01/10 – 12/10	12	25	2,000	279	110	555.09	16.7
Pamunkey River	8-PMK034.17	07/04 – 10/11	86	25	900	105	75	140.88	10.5
Pamunkey River	8-PMK056.87	08/03 – 10/11	51	10	2,000	206	100	347.73	19.6
Pamunkey River	8-PMK082.34	12/05 – 10/11	35	14	650	103	50	126.67	14.3
Pamunkey River UT	8-XDW000.67	01/09 – 12/09	12	100	400	150	100	100	16.7
Pamunkey River UT	8-XDX000.38	01/09 – 12/09	12	100	500	217	200	146.68	25.0
Crump Creek UT	8-XJC001.12	01/10 – 12/10	12	25	2,000	356	220	539.7	41.7
Harrison Creek UT	8-XJD000.02	04/10 – 04/11	12	100	1,300	342	100	391.87	33.3

[1] **Based on the current instantaneous *E. coli* standard of 235 cfu/100mL.**
Statistics are in cfu/100mL